B-WaterSmart

Policy Brief

Fostering circular water infrastructure

Boosting a circular water economy by creating an enabling environment for large-scale systems and infrastructure to support the development of alternative resources

Anika Conrad (adelphi research), Raban Brauner (adelphi research), Kerstin Krömer (OOWV), Minori Matoba (OOWV), Joris de Nies (Proefstation voor de Groenteteelt) **August 2024**

Abstract

Transitioning to a circular water economy—characterized by the efficient, effective, equitable, and safe circular use of water and related resources—presents a promising solution to the pressing issues of water scarcity and pollution. The transition to water-smart societies requires amongst other things the deployment of large-scale infrastructure, encompassing extensive systems, facilities and technologies designed to support the sustainable management of water resources and the recovery of valuable by-products.

This policy brief argues the critical need to accelerate the adoption of a circular water economy by creating an enabling environment for the deployment and operation of large-scale infrastructure. Drawing on insights from two Living Labs (LLs) from the B-WaterSmart EU Horizon 2020 project, East Frisia and Flanders, the document highlights both challenges and enablers and offers targeted recommendations for the EU Commission to foster innovation, investment, and collaboration. By driving forward an enabling environment, these efforts aim to facilitate the widespread implementation of circular water infrastructure on a large scale, thereby boosting water resilience in Europe.

Key messages

Boost investments in circular water infrastructure

Despite projected investments of €438 billion by 2030, EU water reuse rates remain below 3 %. Significant innovation and financial support are required to scale up water reuse infrastructure, including advanced treatment plants and distribution systems to enhance the circular use of water.

Innovative industrial water reuse in East Frisia

The East Frisia Living Lab demonstrates how wastewater from the dairy industry can be recycled through cutting-edge infrastructure such as biological-ultrafiltration-reverse osmosis (Biology-UF-RO) systems. This process not only reduces freshwater demand but also illustrates how infrastructural solutions can optimize resource recovery for large-scale water reuse in industrial processes.

Innovative stormwater infrastructure for agriculture in Flanders

The Flanders Living Lab highlights the potential of integrating stormwater retention basins with existing underground drainage infrastructure to enhance water security for agriculture. By upgrading urban water infrastructure, treated stormwater can be stored, infiltrated, and reused, reducing flood risks, recharging aquifers, and providing a sustainable irrigation supply.

Expand comprehensive funding for water infrastructure projects

To scale innovative projects beyond pilot stages, it is essential to secure comprehensive and sustainable funding mechanisms. Expanding financial support for infrastructure—such as storage, treatment, and delivery systems—will help bridge the gap between small-scale pilots and full-scale implementations of circular water systems.

Reduce bureaucratic hurdles

Clear guidelines on infrastructure approval processes, streamlined permitting, and effective communication with local authorities will ensure smoother implementation and public acceptance.

Enhance public awareness of infrastructure's role in circular water systems

Promoting the role of infrastructure in sustainable water management is essential to foster shared responsibility. Highlighting the benefits of investing in water reuse and stormwater management systems can enhance public understanding and support for necessary infrastructural upgrades. Engaging stakeholders across the value chain is critical for scaling up sustainable practices.

Background

Circular water infrastructure, as defined in this policy brief, refers to systems that align with circular economy principles by closing water loops, reducing resource use, and transforming waste into valuable products. This includes water treatment and recycling facilities, stormwater management systems, and resource recovery systems that convert wastewater, brines, and sludge into resources such as nutrients and energy. Achieving water resilience will require significant technological innovations and their large-scale implementation, along with other complementary strategies that optimize usage efficiency and preserve water quality, ensuring environmental protection and conservation.

The European Commission (EC) is proactively advancing circular economy strategies and initiatives within the water sector. At the UN 2023 Water Conference, the EC emphasized that "promoting circularity in the use of water for industry, energy and agriculture by increasing water efficiency and water reuse" would be treated as a top priority (European Commission 2024). Examples of relevant policies include the Circular Economy Action Plan (CEAP), the EU Climate Adaptation Strategy, the EU Green Deal, Water Reuse Regulation and the revised Urban Wastewater Treatment Directive (UWWTD), which promote circular economy approaches including water reuse and energy and nutrient recovery. The European Council has recently prioritized water resilience for 2024-2029, calling for a EU Blue Deal, representing a comprehensive water strategy for Europe. In the context of the EU Blue Deal it will be necessary to help the most water-consuming industries to gradually adopt technologies to become more water-efficient without compromising and ideally enhancing their competitiveness.

EU legislation indirectly supports the implementation and wider adoption of circular water infrastructure through various measures. These include setting standards for urban wastewater treatment, sewage sludge disposal (Urban Wastewater Treatment Directive), and water quality for reuse in agriculture (Water Reuse Regulation (EU) 2020/741), as well as requiring environmental quality standards for water bodies (Water Framework Directive). Funding for research, testing, and demonstration of innovative circular water technologies is provided through financing programmes from, among others, the European Investment Bank (EIB), Horizon Europe, LIFE programme, and the European Regional Development Fund (ERDF). These programmes offer various financial instruments including grants, loans, and support for innovative technologies, aiming to promote sustainable water management aligned with circular economy principles. Platforms such as the Water Europe Marketplace and Circular Economy Stakeholder Platform promote the exchange of best practices on business models and innovative solutions. The EU taxonomy for sustainable activities guides investments towards eco-friendly initiatives aligned with the European Green Deal, enhancing market transparency and protecting against greenwashing. Furthermore, the EU Corporate Sustainability Reporting Directive (CSRD), effective from January 2023, promotes corporate responsibility and sustainable practices among companies, including water reuse.

Although the ambition of a circular economy is increasingly promoted and the principles well-established, meaningful progress remains elusive across most sectors (Ghisellini et al. 2016). And despite rising investments in water reuse infrastructure by European municipalities - it is projected that capital expenditures will reach €438 billion EUR between 2024 and 2030, with the water and wastewater market expected to grow by 2% annually (Bluefield Research 2024) - water reuse rates in the EU still remain below 3% (WRE 2020; WISE Freshwater 2024). The EU's Water Reuse Regulation (EU 2020/741) acknowledges significant barriers, such as high investment costs and insufficient financial incentives. It advocates for innovative schemes and economic incentives to promote water reuse and potentially avoid less sustainable measures such as desalination and water shipping.

Insights from B-WaterSmart

Despite comprehensive EU policy strategies promoting a circular water economy, scaling up circular water infrastructure faces practical challenges related to financing and permitting processes. This section highlights challenges and enablers encountered in two Living Labs of the EU Horizon 2020 project B-WaterSmart. The project developed and demonstrated technologies and circular economy approaches accelerating the transformation to water-smart economies and societies in coastal Europe and beyond.

The East Frisia Living Lab is committed to identifying and utilizing alternative water sources to meet increasing demand across various sectors. The Oldenburgisch-Ostfriesischer Wasserverband (OOWV) is a leading water utility in Lower Saxony serving approximately one million customers with freshwater from groundwater resources. The water demand in the OOWV supply area has been rising constantly over the past years, necessitating exceptional conservation measures beyond the usual practices. The rising pressure on freshwater supplies has brought some areas close to their water abstraction limits, a situation further exacerbated by climate change.

Water demand is expected to continue growing, partly due to Northern Germany's hydrogen strategy. By 2032, OOWV anticipates needing to supply an additional 30 million cubic meters of water annually, representing a significant increase of almost 40% in water consumption volumes over a short period. To proactively ensure a sustainable water supply, OOWV is exploring and developing alternative water resources, including seawater, surface water, and treated wastewater from sewage treatment plants. The process of purifying these sources to produce ultra-pure water generates by-products such as wash waters, concentrates, and eluates, which must be carefully managed.

One of the notable pilot projects within the B-WaterSmart initiative is the East Frisia Living Lab, which focused on reusing 'cow water' from the dairy industry. This project enhanced the treatment of whey vapor condensate through a combined biological-ultrafiltration-reverse osmosis (biology-UF-RO) process. By transforming process water into a reusable water resource, the project supports circular economy principles by closing resource loops (see **Figure 1**). The results of the B-WaterSmart pilot demonstrated the potential to reduce freshwater demand in dairy food processing from 1 million cubic meters to about 500,000 cubic meters annually. Given that the dairy industry is one of the largest consumers of water in the food and drink sector across Europe, this technology could be replicated to significantly reduce water usage in other regions and industries. These innovative practices contribute to a more sustainable and resilient water supply.

Figure 1: Overview of the Cow-Water quantities.

Flanders LL and piloted infrastructure

In the Flanders Living Lab (LL), a collaborative effort among local water utilities, the municipality, research institutes and technology providers is demonstrating innovative urban stormwater reuse for agriculture, introducing alternative water resources. As climate change intensifies, local farmers are increasingly demanding more irrigation water. At the same time, the region faces more extreme rain events, causing short-term flooding in Flanders and reducing soil infiltration capacity. This has prompted the LL municipality of Mechelen to enhance flood protection and recover groundwater tables. Despite these challenges, urban stormwater remains a largely untapped resource for local water supply.

To address these challenges, a newly installed stormwater retention basin will store rainwater for agricultural use during water demand. The rainwater is then used for subirrigation of nearby fields by converting the existing drainage system into controlled drainage, allowing water to flow into drainage pipes and infiltrate the soil. This water is partially absorbed by plants through capillary rise for evaporation, with the rest replenishing the groundwater. By this, the subirrigation system effectively serves a dual purpose: draining excess water and adding water to the system when needed. The pilot set-up is visualised in **Figure 2**. To optimize the system's performance, the B-WaterSmart pilot project developed a management tool to control water levels in the basin to distribute the water to the irrigation system based on water level, water demand, and prediction of precipitation events. This initiative not only reduces urban flooding and protects ecosystems via increased groundwater recharge, but also benefits farmers, who have access to a more reliable water supply for irrigation, increasing water security and thus climate resilience by improving water reuse in the region.

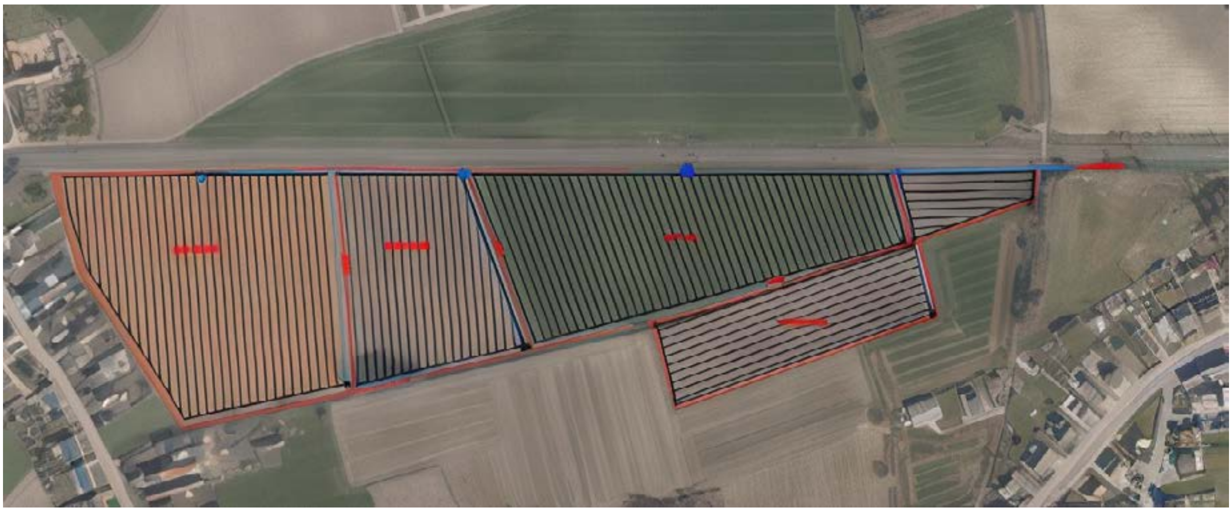

Figure 2: Involved fields for subirrigation (blue dots: water supply position from basin, black dots: remote controlled drainage pit, blacklines are drainage/infiltration pipes.)

Gaps, challenges and enablers for large-scale infrastructure implementation in the B-WaterSmart LLs

Financing

High initial investment makes it challenging to develop attractive business models

A primary barrier to water infrastructure investment in both Living Labs is financial. High upfront costs, coupled with limited access to funding sources and unfavorable financing terms, present significant obstacles. Traditional financial models—relying on a balance of tariffs, public funds, and external subsidies—often fail to generate sufficient income to cover both operational and capital expenses, making it difficult to ensure long-term financial sustainability (Machete and Marques 2021). In both LLs, the lower pricing of conventional freshwater supply compared to alternative water resources, particularly reclaimed water, has presented challenges to increasing demand for the latter. For example, without any funding in East Frisia LL, the price of reclaimed cow water could be twice as high as the current drinking water price due to high investment costs. However, there are successful examples in other regions where circular water infrastructure projects have achieved financial sustainability, suggesting that, with the right funding mechanisms and policies, these systems can become viable alternatives. In both LLs, traditional business models have struggled to cover high initial investments and ongoing operational costs, highlighting the need for tailored financial solutions to support the development of alternative water resources.

Short-term financial goals and quick decision-making among industrial customers increase financial risks for public water utilities

Industrial customers typically seek a return on investment within three to five years. However, water reuse projects often require longer-term commitments, with capital investments depreciating over a period of 10 years or more. This difference in financial expectations can place public water providers at risk, especially when they are involved in managing or maintaining infrastructure that requires substantial private investment. If such projects fail to generate expected returns, public utilities may face operational challenges or financial strain in ensuring the infrastructure remains functional.

Grants and subsidies at EU and national levels were received in both LLs but were insufficient to cover initial investments

Securing additional financing is crucial to address the upfront capital expenditures and costs associated with new water infrastructure projects. However, at both Living Labs (LLs), grants and subsidies from EU and national sources were found to be insufficient to cover all the financial needs related to implementing new water infrastructure. Private funding is often limited due to the high risks and uncertainties associated with technological innovation, compounded by regulatory challenges and the complexities of tariff setting and contract procurement processes. This highlights the urgent need for stronger public sector involvement to bridge the financing gap and manage risks, especially during the early stages of technology development. However, despite a broad public funding landscape for research and innovation, both LLs report that pilot projects aiming for replication and full-scale implementation face inadequate support. In East Frisia, current funding programs only cover up to 20-25% of the necessary capital expenditure, usually even lower. Furthermore, most funding programs support innovations only once, reducing the likelihood of securing similar grants in the near future. Stakeholders in Flanders LL consider payments for ecosystem services as promising, but they have not yet been implemented due to the lack of a comprehensive legal and financial framework, which would include clear legal guidelines, stable funding mechanisms, and institutional support to ensure effective implementation and sustainability. Currently, project partners are not aware of any additional funding opportunities that could sufficiently reduce investment risks. To ensure the successful implementation of water reuse projects, it will be crucial to develop more robust and accessible funding mechanisms, which could include both public and private sector solutions, such as forgivable loans or risk-sharing partnerships.

Legislation

Little established approval process

In East Frisia, recent amendments to the Drinking Water Ordinance and the Food and Hygiene Ordinance in June 2023 have improved conditions for water reuse projects by allowing deviations from the drinking water quality requirements if the food product is not adversely affected. However, significant bureaucratic hurdles persist in order to obtain this permission. The approval process for water reuse schemes is still unclear, with no detailed guidelines for obtaining related permits for food production. The involvement of multiple authorties makes the coordination and communication between them challenging, which further complicates decision-making. This lack of clarity can result in approval times of up to two years and result in inconsistent decisions between federal states, creating considerable uncertainty for solution providers and private investors. The same applies to LL Flanders, where project partners criticized the extensive effort required to obtain a permit, even for demonstrating technologies at a very small scale.

Few examples of circular water infrastructure

As circular economy approaches are still relatively new, authorities have only little regulatory experience in areas such as the approval of water reuse schemes / systems and the discharge of wastewater, concentrates, and eluates into surface waters and the sea, leading to costly and time-consuming consultations and audits.

Unclear role allocation due to lack of a mandated problem-owner

While national documents highlight the importance of water reuse, specific measures and clearly assigned tasks from the state have yet to be established. This has presented challenges, but it also offers an opportunity to promote more collaborative, 'bottom-up' initiatives. These collaborative approaches foster cross-sector stakeholder engagement, which is essential for effective water governance and resilience. In LL Flanders, the reuse of stormwater has highlighted the need for clearer role allocation among stakeholders to manage risks from extreme weather and ensure sustainable financing for flood protection and drought resilience solutions. Strengthening the coordination and capacity of regional and local governments to support these new solutions would be a valuable step forward.

Lack of regulation for stormwater reuse in Flanders

Presently, Flanders lacks specific legislation for stormwater reuse to enable effective exploitation of this resource. Clear definitions are needed to classify stormwater preferably as rainwater, as a classification as wastewater reuse involves stringent quality standards that result in prohibitively high costs. However, stormwater quality can vary significantly depending on the source, and water collected from areas such as road surfaces, industrial sites, or agricultural runoff may contain contaminants like heavy metals, hydrocarbons, or pesticides, requiring adequate treatment before reuse. Results from the B-WaterSmart pilot project indicate that natural infiltration of stormwater, when sourced appropriately and following basic treatment, does not require the stringent quality standards typically associated with wastewater reuse.

Stakeholder engagement and awareness raising

Stakeholder engagement and awareness raising

Education and stakeholder engagement have proven crucial for successful technology implementation. The B-WaterSmart project highlighted that transparent communication among participants is essential for harnessing synergies and coordinating solutions, particularly in water reuse projects. Activities in both LLs stressed the importance of clear communication about public benefits and impacts, especially in terms of environmental sustainability, while also addressing safety and health concerns. In Flanders, stakeholder engagement has been key to securing investment and fostering collaborative arrangements. These arrangements have the potential to serve as meaningful contributions to the development of new water governance models, offering lessons for future governance frameworks that integrate cross-sector collaboration and participatory approaches. Additionally, the Community of Practice model used in the project was well-received, enabling more in-depth dialogue with authorities and between sectors, strengthening legitimacy, and paving the way for future innovations in water governance.

Opportunities and policy recommendations

Addressing the gaps and challenges identified in the B-WaterSmart Living Labs requires a multifaceted approach that combines enhanced financing mechanisms, streamlined legislation, and robust stakeholder engagement. By implementing these recommendations, the EU can facilitate the successful development and scaling of circular water infrastructure, thereby advancing sustainability and resilience in water management across Europe.

Extend funding opportunities for scaling pilot projects, including grants, subsidies and investment incentives.

Expand and diversify grant and subsidy programs to cover a larger proportion of capital expenditures for large-scale infrastructure. Ensure that funding is more comprehensive and adaptable to different stages of project development, including early-stage innovations and full-scale implementations. Provide better financial risk-sharing mechanisms such as insurance schemes or government-backed guarantees to reduce the financial burden on public utilities and encourage private sector investment. However, solution providers must also proactively engage with investors and financial institutions to better understand how risks are priced in circular economy projects. This includes recognizing that circular supply chains often entail longer-term relationships, which require more comprehensive risk evaluations. Investors are increasingly considering factors such as the resilience of circular supply chains, the strength of collaborative models, and long-term agreements that align incentives across stakeholders. By aligning project development with these risk assessment practices, solution providers can better attract private investment and enhance their financial strategies. Agreed ways of calculating the full costs and value of water, ecosystem services, and water-smart innovations are also needed to ensure market compatibility and incentivize investment. Other incentives may include, but are not limited to, tax breaks, non-interest loans, and streamlined licensing processes. This is particularly important, as the EU can act as a trendsetter and thereby unlock similar national funds.

Provide detailed guidelines for permission processes to reduce bureaucratic hurdles, especially for small pilot plants.

Lengthy permission processes, even for small pilot plants, cause unnecessary high transaction costs and often exceed local capacities. While EU-wide guidelines can help streamline these processes, it is crucial to recognize that risks are highly context-dependent. Therefore, allowing for flexibility in how these guidelines are implemented at the local level would help ensure that they address the unique challenges of different regions. Providing a Europe-wide framework with adaptable recommendations could clarify responsibilities while enabling Member States to modify the approach according to local conditions, reducing bureaucratic hurdles without compromising on regional needs.

Organise and facilitate knowledge exchanges formats and integration between both relevant authorities and other circular water solutions in Member States, the EU and beyond.

As of today, circular water innovations are mainly stand-alone initiatives that would benefit substantially from knowledge exchange formats with similar practices across sectors to exploit synergies. The same applies to a closer integration with and exchange among relevant authorities to support approval processes.

Promote public engagement, awareness, and communication to scale innovative circular water management solutions.

Raising awareness about the public benefits of circular water management is crucial for scaling innovative solutions and increasing acceptance of water reuse, which often involves significant public health risks. It is important to engage value chain actors, both upstream and downstream, to enhance shared problem ownership and encourage investment. The Community of Practice (CoP) model used in B-WaterSmart was particularly effective as a 'door opener' for meaningful consultations, including with local approval authorities, and serves as a strong example for establishing efficient communication channels. Further support of the development of CoP and other participatory approaches are recommended to facilitate dialogue among stakeholders, including authorities, industry, and the public.

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Further Reading

Guidelines on Financing CE projects (B-WaterSmart Deliverable 4.5)

Guidelines & recommendations for regulation and policy instruments (B-WaterSmart Deliverable 5.6) (Cardoso et al. 2024)

Final report on social acceptance and behaviors towards water-smart solutions (B-WaterSmart Deliverable 5.7)

See the download section of the B-Water Smart website b-watersmart.eu for further reading.

Imprint

This policy brief was compiled by Anika Conrad (adelphi research), Raban Brauner (adelphi research), Kerstin Krömer (OOWV), Minori Matoba (OOWV),
and Joris de Nies (Proefstation voor de Groenteteelt) based on the work of the research project B-WaterSmart. The authors also express their gratitude for the quality assurance of Paul Jeffrey (Cranfield University) and Carla Gomes (ICS-ULisboa).

Coordination and Contact

Anika Conrad
Advisor
adelphi research

conrad@adelphi.de
b-watersmart.eu

Suggested citation

Conrad, A.; Brauner, R.; Krömer, K.; Matoba, M.; de Nies, J. (2024) Fostering circular water infrastructure: Boosting a circular water economy by creating an enabling environment for large-scale systems and infrastructure to support the development of alternative resources.

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Policy Brief | Fostering circular water infrastructure: Boosting a circular water economy by creating an enabling environment for large-scale systems and infrastructure to support the development of alternative resources - August 2024

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 869171. The publication reflects only the authors' views and the European Union is not liable for any use that may be made of the information contained therein.